The Physical Science International Kitchen: Making Physical Science Accessible to All

Journal:	*The Science Teacher*
Manuscript ID:	Draft
Manuscript Type:	Feature
Keywords:	Chemistry, Physical science, Physics, Simple machines, Inquiry skills

Introduction

According to constructivist views (cognitive constructivism by Jean Piaget and social constructivism by Lev Vygotsky), learners do not simply come in the classroom as blank slates rather they have their pre-existing beliefs, which they have accumulated from daily interaction with the environment (e.g., family, friends, nature, TV) that they use in order to make meaning of new information. Thus, Palmer (2005) stresses that students need to construct knowledge by accessing their preexisting beliefs within or without the social environment. These investigations must be designed to be relevant, not only to the day to day lives of our students, but also culturally relevant according to Ladson-Billings (1995) to allow students from diverse backgrounds to connect the content to their experiences while at the same time educating mainstream students about cultures different from their own.

Furthermore, these activities must help move students from lower to higher level thinking skills as illustrated in Table 1 (Costa, 2001). For example, students will have to first identify the best choice to perform a given task and then classify substances or objects. By classifying various items, students move from Costa's first level of thinking into the second level. Students will then move to the 3rd level through application of their base knowledge to a real world scenario.

Costa's Levels of Thinking (Costa, 2001)		
Level 3	Applying	Evaluate Generalize Imagine Judge Predict Speculate If/Then Hypothesize Forecast
Level 2	Processing	Compare Contrast Classify Sort Distinguish Explain Infer Analyze
Level 1	Gathering	Complete Define Describe Identify List Observe Recite Select

Table 1

This article features two physical science activities that are designed to help students learn different science concepts through process skills and explore different cultures. These laboratory investigations were designed by a diverse team of pre-service and experienced teachers with rich experiences in the military, industry, and the classroom in not only the United States, but around the world. Both lessons are for high school students and have been tested in classrooms. Through the physical science international kitchen exploration, students will connect scientific standards with real world problems and experiences in a manner that is culturally relevant.

Apple Browning Lab

Objective

Last week, I received a phone call from my Egyptian friend, Nailah. During our conversation, she complained that her daughter would not eat apples after they turned brown. She typically coats that apples with lemon juice, but recently had been "hard-pressed" to find fresh lemons or lemon juice at her local market. The shortage has been linked to current weather patterns, namely freezing conditions in Argentina and drought conditions in Spain. Due to my scientific background, she was hoping that I could recommend another substance to use in place of the lemons.

Many fruits contain an enzyme, tyrosinase, which will cause the fruit to turn brown once the fruit is cut and is exposed to oxygen found in the air. The purpose of this lab is to investigate the cause of browning in apples and to test the effects of common kitchen on the rate of browning on fruits, in order to identify another substance that Nailah might be able to use to prevent the browning of apples.

Note to the Teacher

Depending on your class length, students may be asked to develop a procedure for homework or in a previous class period. This activity could be enhanced by allowing students to experiment with substances that are commonly used in other countries. Students will need some background information on acids, bases, and indicators. Some students may require additional support or scaffolding to increase their comfort with this inquiry.

Materials

- apples cut into slices
- common kitchen substances with known and unknown pH values
- pH-indicating paper
- plastic cups/containers
- graduated cylinders

Item	pH (approx)	Item	pH (approx)
Cleaner w/ ammonia	12	Baking soda solution	
Distilled water	7	Drinking water	8
Eggs		Grapes	
Sugar water		Vitamin C	
Apple juice		Limewater	
Milk of magnesia		Orange juice	
Soda lye	14	Sour milk	4
Tomato juice		Vinegar	3

Table 2

Procedure

1) Develop a hypothesis, a prediction of which substances will work best to prevent browning in the apples. Be sure to incorporate any knowledge of acids and bases as an explanation for why a particular substance will work best.

2) Design an experiment (without use of an indicator) to test the ability of each substance to reduce the browning of cut apples.

3) After you have received permission from the instructor, conduct the experiment and create a table to rank each substance on the pH scale from most acidic to most basic.

4) Next, you will verify your results by using pH-indicating paper to check the accuracy of your findings. You may use Table 2 as your guide.

5) After analysis of your data, predict an appropriate substance for Nailah to use to prevent browning of her apples. As a class, we will make one final recommendation so be prepared to defend your choice by identifying both advantages and drawbacks to using various substances.

Rubric:

Students can classify common substances as acids or bases based on degree of apple browning	/5
Students can determine the pH of common substances using indicator paper	/5
Students can explain how and why various substances prevent or reduce the browning of apples	/5
Students can select an appropriate substance to use (in place of the lemon juice) to prevent browning of apples	/5
Students participate in the lab activity and discussion by using knowledge of science to defend their choice of substance	/5
Total	/25

Table 3

Picture 1: Students pouring different substances on slices of apples on different containers.

Simple Machines Lab

Objective

Several weeks ago, I was having a discussion with Ms. Price from the social studies department about her recent travels to the Philippines. During our conversation, she expressed her frustration that she could not commonly find a corkscrew (machine to open wine) because her research often takes her to remote villages and rural areas. Due to my scientific background, she was hoping that I could recommend another machine or device to use until she had an opportunity to ask the native people.

The purpose of this activity is to allow students to explore simple machines that might be found in the kitchen through a problem-based learning inquiry activity. Students will be presented with a description of the basic classes of simple machines and their function. Then they will participate in an activity designed to have them solve a series of problems. Given a series of tasks, each lab group will have to decide on the best kind of simple machine, in the form of a kitchen utensil, to perform the tasks (Table 4). Finally, based on this knowledge of simple and compound machines, students will identify an appropriate substitute for Ms. Price to use during her next trip.

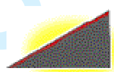
Note to the Teacher

This activity works especially well if you are able to obtain unique, antique, or even international utensils to which your students may not have previous exposure. Be sure to take advantage of explaining compound machines in this activity. Some students might require a demonstration of how a specific utensil is used. You can answer questions for them or provide a short explanation with each tool. In the calculations activity, your students can determine that Archimedes would need to locate a planet 1.0×10^{23} km from Earth. Large numbers are daunting

for students, especially those with limited experience with scientific notation, so this can serve as an excellent scaffolding opportunity. There is another good way of demonstrating mechanical advantage – have students use a lever to lift a textbook of a known mass with a lever of known length (meter sticks work well) using a spring scale.

Materials

- various kitchen tools
- spring scale

Types of Simple Machines / Examples of Simple Machines	 **Lever**	 **Incline Plane**	 **Wheel and Axle**	 **Screw**	 **Pulley**	 **Wedge**
Roll out pie dough (rolling pin) 						
Raise/lower a mini blind 						
Cut Vegetables 						
Eat sushi (chopsticks) 						

Remove a Cork from a Bottle 						
Corngrind or Metate 						
Hand mixer (compound) 						
Combination wine opener/bottle opener (compound) 						

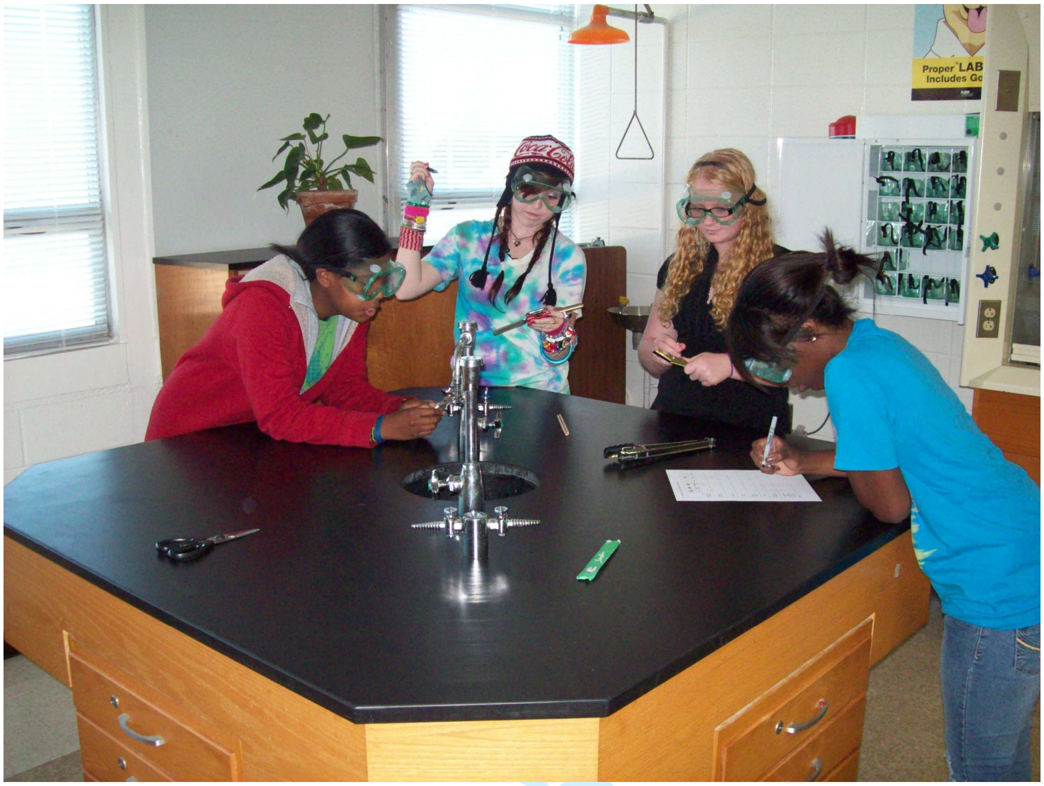
Table 4

Procedure

1. In small groups, rotate through lab stations, which have few of the utensils, at each station.

Table 4 may be used to organize the simple machines.

2. With the following scenario, calculate resistance force and mechanical advantage.



Picture 2 Students investigating simple machines

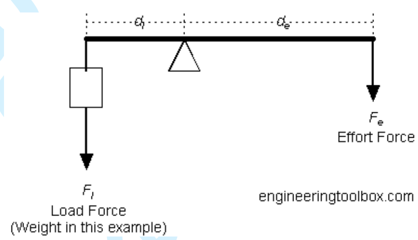
		
Mass of the Earth (resistance force)	**Strength of Archimedes (effort force)**	**Length of lever (F_1D_1=F_2D_2)**
$6.0x10^{24}$ kg	**60 kg**	**$1.0x10^{23}$ m**

Table 5

Archimedes said, “Give me a long enough lever and a place to stand, and I will move the world.” This will be the next goal of your physical science class. The mass of the Earth is 6.0×10^{24} kg (Table 5). Assuming the maximum effort force of the typical human is about 60 kg, determine the length of the fulcrum Archimedes would have had to use. Assume the fulcrum is placed as close as possible to the Earth, maybe 1 meter. Finally, calculate mechanical advantage using Table 6.

3. Based on the data you have gathered, which of the following readily available tools can be an efficient substitute to a corkscrew that Ms. Price can use: nail, fork, or a scissors? We will use this decision to inform Ms. Price of our recommendation so be prepared to defend why this alternative tool is our best choice.

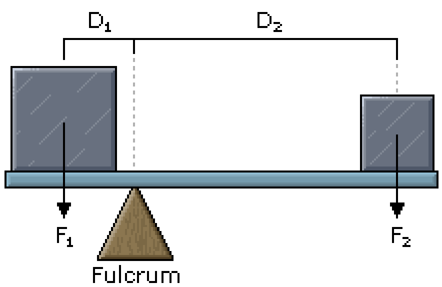
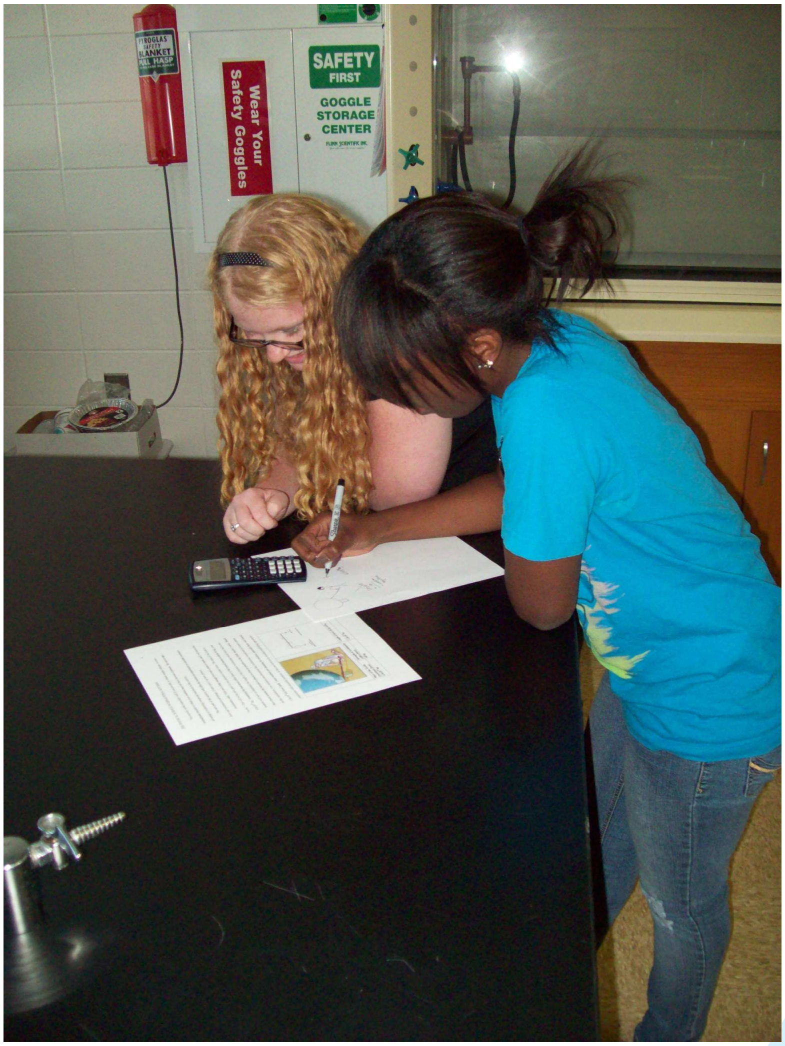
	$MA = \frac{\text{length of effort arm}}{\text{length of resistance arm}}$ -or- $MA = \frac{D_2}{D_1}$

Table 6

Rubric

Students can classify types of simple machines	/5
Students can recognize simple machines that make up compound machines	/5
Students can calculate the length of a lever given the effort and resistance forces	/5
Students can calculate the mechanical advantage of a lever	/5
Students participate in the lab activity, offer meaningful insight, and perform their own calculations	/5
Total	/25

Table 7



Picture 3 Students calculating lifting the Earth with a lever

Conclusion

As educators, it is our responsibility to change the way our students think about science. It is not necessary to enter the laboratory to “do science,” in fact science is a part of our daily lives from cleaning the house to making dinner, or driving to school. Many students possess an understanding of scientific processes and phenomenon from practical experience that can be harnessed to help students understand more abstract scientific concepts. Teachers can also create environments that will infuse multiple cultures as a means of increasing access to science for all

students. Here are a few quick suggestions to transition traditional lab activities into more culturally relevant and inquiry-based experiences for your students.

- Create a real world problem or scenario to give meaning to the activity.
- Share your knowledge of other cultures by incorporating real names, indigenous knowledge, and current events into the investigation. (This may be a great opportunity for you to learn more by conducting research or communicating with teachers from other disciplines.)
- Increase students inquiry skills through appropriate scaffolding, first have the students build skills and techniques by going through an organized procedure and then allow students more free reign by asking an open-ended question.
- Allow students to use the language of science and preexisting knowledge by encouraging students to discuss and explain their recommendations.

Safety Note
1. Standard laboratory safety procedures should be followed for each activity.
2. All substances should be disposed of as directed by teachers
3. Exercise care when handling common tools and never play in a laboratory environment.
4. Food items are not intended for student consumption.

References

Costa, A. L. (Ed.). (2001). *Developing minds: A resource book for teaching thinking, 3rd edition.* Alexandria, VA: ACSD.

Ladson-Billings, G. (1995) But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice, 34*(3), 159-165.

Palmer, D. (2005). A motivational view of constructivist-informed teaching. *International Journal of Science Education.* Vol. 27, No. 15, 16 December 2005, pp. 1853–1881.